A FUNCTIONAL ANALYSIS OF OBSIDIAN FLAKES FROM THREE ARCHAEOLOGICAL SITES ON GREAT BARRIER ISLAND AND ONE AT TOKOROA

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Abstract. Experimentally-determined functional ranges are used to analyse the obsidian flakes from four prehistoric sites. These are an inland Archaic site from Tokoroa, and three sites of differing ages from Harataonga Bay, Great Barrier Island. The results of the flake tool analysis for each site are related to other archaeological evidence of past activities, and environmental resources. The functional ranges for the flake tools were also used as the basis of a typology for inter-site comparisons in which site and inter-site implications are discussed.

In New Zealand formal typologies of flake tools have not been successful because of the morphologically undifferentiated nature of most flaked tool assemblages (Shawcross 1964). Concentration on the functional attributes of such assemblages overcomes this difficulty, and has been undertaken both as an alternative to technological studies, and because studies of stylistic or technological features assume functional control.

For this analysis, experiments were conducted to establish parameters of functional significance, and then functional ranges for different tasks were defined in terms of these parameters. The results were then applied to four assemblages from the Auckland area. The functional distribution of obsidian at each site was then related to environmental resources and other archaeological evidence of site activities.

In the experiments flakes and cores of Mayor Island obsidian were used. The most obvious effect of obsidian use was edge damage, which was of two types: unifacial and bifacial. Unifacial edge damage resulted from scraping where only the ventral face of the tool was in contact with the material and short, small-use flakes were removed from the leading face. Bifacial edge damage resulted when both faces adjacent to the working edge were in contact with the material being worked and flakes were detached from both.

This may be associated with cutting, but not always. If an acute angled edge is used for scraping, the resulting depth of penetration into the material can lead to bifacial damage, as can turning the tool over during scraping use. Also included in this category of bifacial alteration is the snapping of small "bites" from the edges of thin blades.

Two types of use-wear were distinguished: dulling of the natural glossy lustre of obsidian by friction can occur during use, while small scratches or grooves known as striations can form on surfaces (e.g. Semenov 1964).

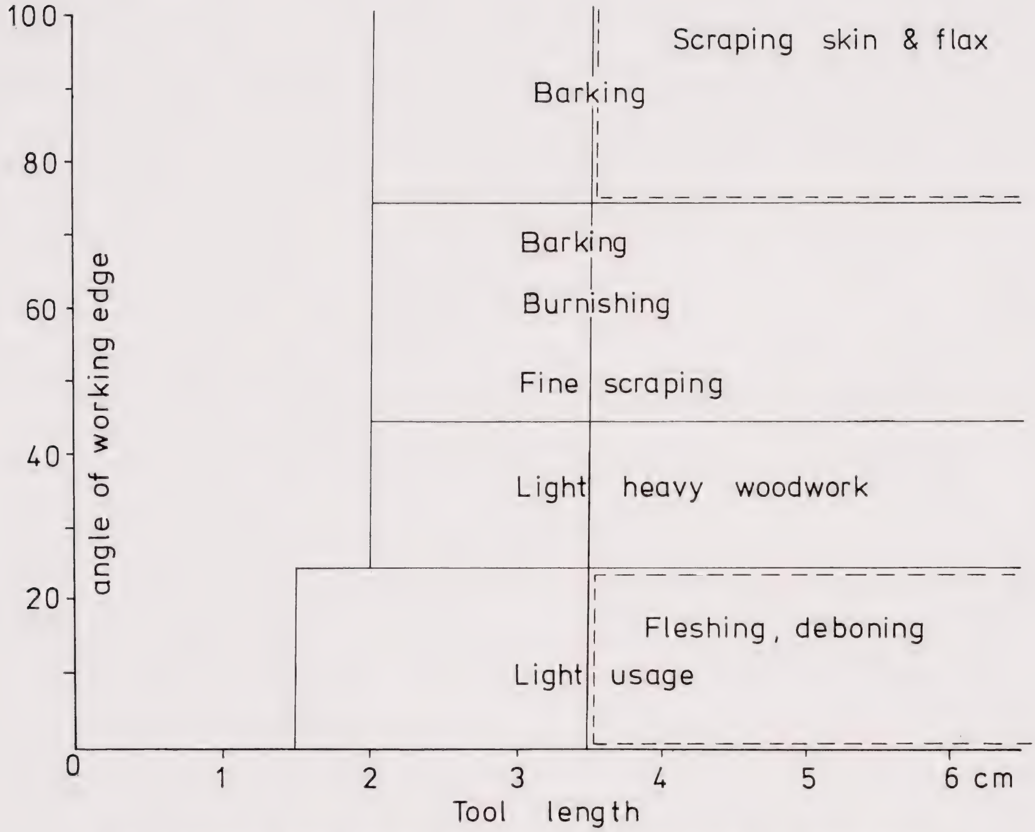

Fig. 1. Graph of experimentally-determined functional ranges for obsidian tools.

The factors determining the suitability of a particular tool for a specific task were found to include the shape of the working edge, the angle of the working edge, and the "graspability" of the tool.

Maximum dimension was found to be a function of breadth x thickness and therefore an assumed function of the ability of a tool to be grasped (Figs. 2, 5, 8, 10). On this basis, length was plotted against angle of the working edge of used pieces in order to determine ranges of these factors suitable for particular tasks. These ranges were then later used in a functional analysis of archaeological examples for which the same measurements and observations were made.

The experimental results have been outlined in terms of angle and dimension changes (Fig. 1). These, used in conjunction with edge shape and size characteristics, as well as use-wear type, provide a framework for functional analysis. A more detailed treatment of the experiments and their implications is provided in Morwood (1974).

The Sites

Four assemblages from the Auckland area were studied; one from an Archaic inland site at Tokoroa (N75/1), and three of different ages from Harataonga Bay,

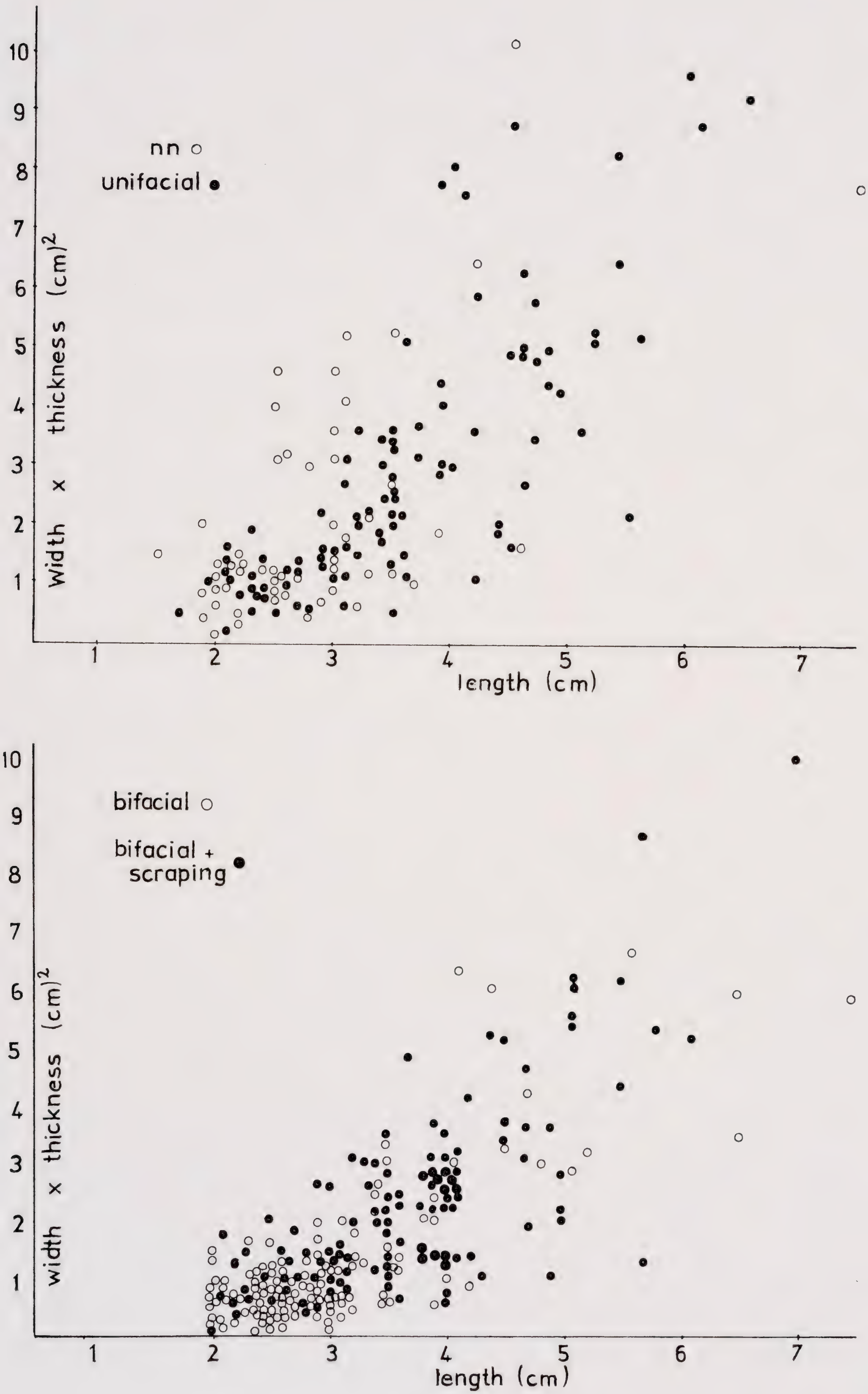

Fig. 2. Dimensions of obsidian from Tokoroa, N75/1.

Great Barrier Island (N30/3, N30/4, and N30/5). The choice was determined by practical considerations of the availability of the assemblages for study, but there were also theoretical considerations. The inland assemblage could be contrasted with the coastal sites to determine the effect (if any) of different environmental resources on flake tool morphology. A criticism of a functional analysis of flaked tools for interpreting economic activities has been made, "In addition, flaked stone tools appear to be machine tools rather than tools directly employed for food production . . . and therefore likely to continue to be used for similar tasks irrespective of the economy of their makers" (White 1971, p. 49).

This study was deemed a way of testing this criticism. Similarly the three coastal sites could be used to delimit cultural determinates of flake tool morphology given the same environmental resources. With experimentally established parameters, functional variation seems the easiest to isolate and allows the significance of cultural and technological differences to be gauged. This overcomes the naive assumption that differences between flake tool assemblages are of cultural significance only.

The method employed in the site analysis was to interpret the obsidian material using features earlier found to be significant. This was related to exploitation of resources evident at the site using ethnographic accounts where possible.

Tokoroa (N75/1)

One of the few early inland sites known from the North Island, the occupation has been assigned to the Settlement Phase for the area by Green (1970). This is supported by the high percentage of Mayor Island obsidian and the occurrence of moa at the site. The stratigraphy revealed formation of a podsol, indicating forest prior to the initial occupation. Most likely this would have been rimu forest now typical of the area. At the time of European contact, the vegetation in the area was predominantly scrub and fern, probably fire-induced. The food resources available to the first occupants of the area were, therefore, berries — *hinau, rimu, matai, kahikatea,* other vegetable foods, fungi and birds — pigeon, *kaka, tui, kiwi* and *moa* (Best 1907; Colenso 1880). The site was located on a small stream flat which would have provided minimal aquatic resources in comparison with, say, the Lake Ngaroto sites, where eels are thought to have been an important food source (Cassels 1972). The close proximity of the site to the stream, therefore, suggests the latter's value for movement or for water requirements rather than a source of food. This plus the diffuse nature of resources in an inland forest area would indicate a short occupation by people in transit. There is no evidence for any significant exploitation of potential forest foods as the faunal material is restricted to the remains of two (possibly three) moa of a small species, *Euryapteryx exilis.* In his report on the excavation Law (1973) has stated that the site was used for hunting moa. This is doubtful as the remains were of leg, toe and pelvic bones only, indicating that these birds were butchered elsewhere and brought to the camp from some distance.

The only artifacts recovered during the 1962 excavation were 510 pieces of obsidian and several adze flakes. The obsidian was sourced — 94% from Mayor Island — and has since been ignored. For this site, therefore, a functional analysis of obsidian tools is fundamental to understanding the activities undertaken during occupation.

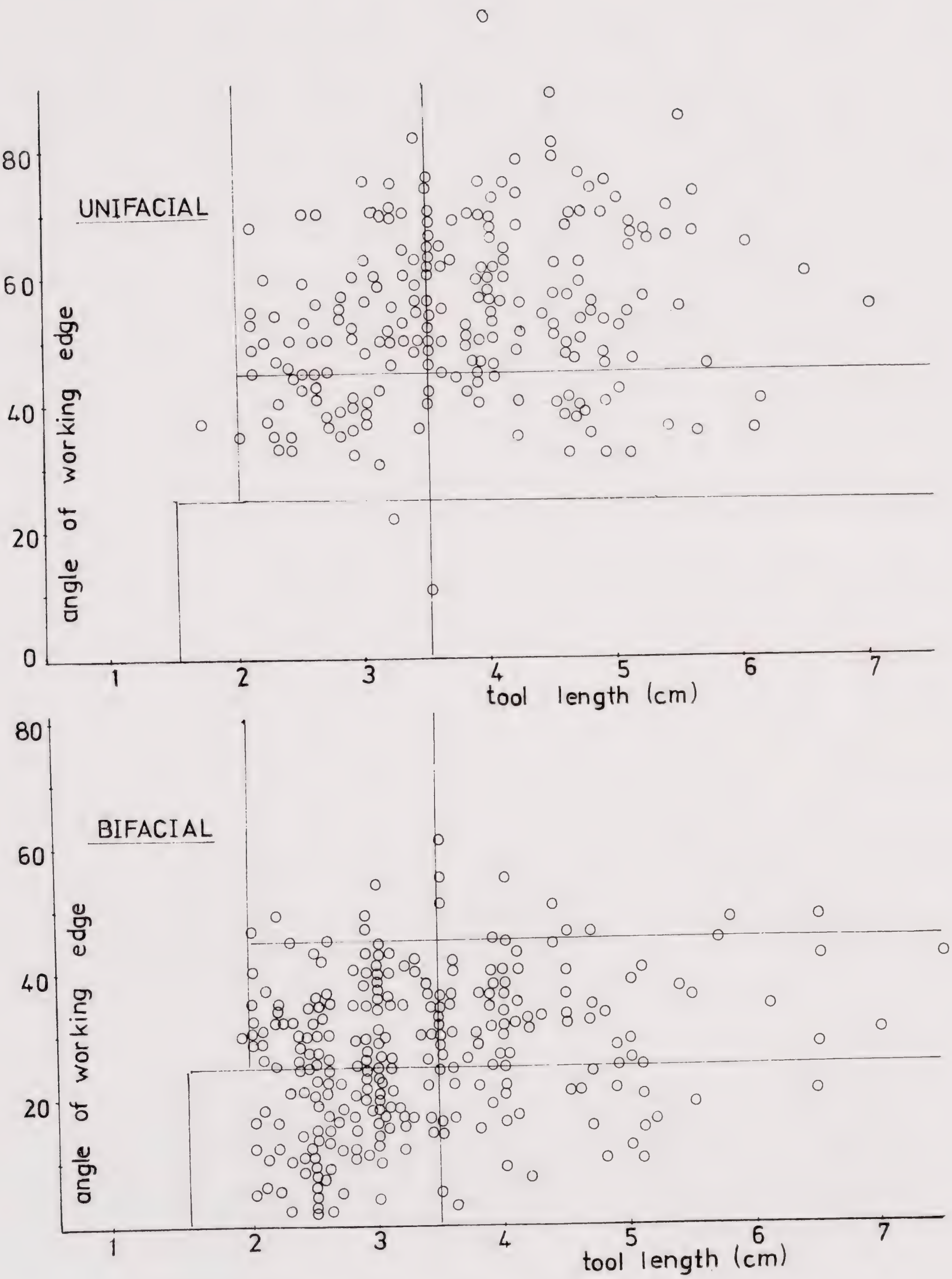

Fig. 3. Functional distribution of used obsidian from Tokoroa, N75/1.

Of the 409 pieces now available for study only 53 pieces (13%) showed no detectable sign of use and were categorised as not necessarily used (nn).

Graphs of length against breadth x thickness (Fig. 2) showed that not necessarily used obsidians clustered in the small size range, reflecting either functional discrimination against this size range or the difficulty in identifying use-wear in this category. The fact that the majority of used flakes also cluster in this area indicates the latter and it is likely that all of the obsidian recovered had been used. Certainly the high percentage of used obsidian plus the apparently opportunistic use, indicates that obsidian tool manufacture was carried out either at some unexcavated part of the site, or elsewhere. The size distribution of tools exhibiting unifacial and bifacial edge damage are similar but marked differences occur in the distribution of edge angles (Fig. 3). Obsidian experimentation has shown that these differences in angle distributions for the two types of edge damage result from the physical properties of obsidian rather than functionally or culturally determined choice. If an acute angled edge is used for scraping then it will incur bifacial edge damage (Fig. 4). If this factor is weighted for in the analysis, then it is found that the distributions of both scraping and cutting tools are similar, a fact consisent with both opportunistic use and the necessity of performing both operations in woodworking tasks. Functional significance can only be attributed to the differing angle distributions if a perfect unifacial/scraping, bifacial/cutting correlation is assumed, and experimentally the assumption is not valid. This means that scrapers, associated with maintenance activities, are under-represented if distinguished by unifacial edge damage. The frequency of co-occurrence of factors indicating scraping — unifacial damage, notching, and striations

Fig. 4. Obsidian showing the co-occurrence of bifacial edge damage and concavities indicating the working of shafts. Approx. actual size.

at right angles to the working edge — and bifacial damage was 42% (Table 1). As this represents the bare minimum frequency of co-occurrence, then obviously tasks involving both operations were a sizeable component of site activities, i.e. woodworking.

Table 1. Analysis of obsidian, N75/1.

	No.	%
Total no. studied	409	
No. showing use	356	87
No. of working edges	480	
No. showing bifacial damage	265	55
Co-occurrence of bifacial damage + scraping		42

Figure 3 can be interpreted using the experimental results. There is a minimum length of 2 cm for used pieces evident and this approximates the experimentally determined minimum for hand-held use. This may be evidence that hafting was not a feature of this assemblage, which is supported by the fact that the severity of edge damage on all specimens does not exceed that expected from unhafted use.

The minimum 2 cm length of the material could also result from the excavation technique employed as the soil was not sifted (R. C. Green, pers. comm.). Once again this would demonstrate the difficulty in handling obsidian of less than 2 cm.

The length against angle of working edge distribution for bifacially damaged edges (Fig. 3) shows that the majority of tools are of light usage and light woodworking categories. This was supported by the co-occurrence of scraping criteria and the use-damage type, edge damage on specimens with edge angle greater than 25° was well defined and regular. All specimens were examined under 10 x magnification but no example of the matted appearance, characterising butchering use-wear, was found.

The distribution of working edge angles and tool length for unifacially damaged edges was at first puzzling for 70% of the points clustered in a region which experimentally had proved suitable for fine-scraping and burnishing. However, in reconstructing the diameters of wood that was worked, on the basis of edge contours, it was found these varied from 6-30 mm with most clustering about 15 mm in diameter. Scraping would, therefore, be primarily concerned with the removal of bark and soft sapwood rather than fibrous woody tissue.

The assemblage reflects a restricted range of maintenance activities rather than extractive, which is compatible with the minimal exploitation of forest resources that the faunal remains (or lack of) suggests. On this basis one would conclude that the occupation was a transient one. The Tokoroa site certainly presents a contrast to the Whakamoenga cave, Lake Taupo, site (Hosking 1962). There a basal Archaic layer contained the remains of small birds, rats, fish, tuatara, shells and moa while artifacts included an adze, bird spear tips, pumice, chert, greywacke and a small number of obsidian flakes and cores. Thus the Lake Whakamoenga cave site provides evidence of a wide range of activities, both extractive and maintenance, which were not represented at Tokoroa. However, there are other factors to be considered. The quantity of obsidian found indicates a level of maintenance activity not expected for a transient camp and the percentage of pieces showing use demonstrates that the tools were not manufactured in the area excavated. The occupation may have been for longer then, than the food remains would indicate, for little trace need remain of exploitation of plant resources, while for forest birds Pike (1973) notes accounts of bones and entrails of birds being consumed: "Thus the absence of forest-bird bones on a site does not necessarily mean that the birds were not being eaten but just preserved elsewhere, or else the bones and entrails were being consumed as well leaving no trace" (Pike 1973, p. 5).

If so, then the site may have been a base camp (Binford & Binford 1969) and the activities represented in the excavated area could be only a small component of the total site activities. This idea is supported by the specialised nature of the assemblage and the amount of used obsidian recovered. Also, sporadic finds of adzes and a large obsidian core had previously been made at the site and these are not represented in the excavated assemblage.

The paucity of artifactual and faunal types may be due to the area chosen for excavation rather than a minimal occupation period. Ranapiri (1895) lists the methods of procuring birds that were used by the Maori, including various snares and spearing. The reconstructed size range of materials worked indicates particular emphasis on the working of shafts, and many of these are appropriate for use as spear-shafts. Whether this site was as specialised as the assemblage indicates or whether the excavated assemblage represents a specialised component of a much broader range of site activities depends on the nature of the sample taken.

Great Barrier Archaic Midden (N30/5)

This Archaic site is an area of midden just above the high tide level. Two of the three squares excavated in 1962 were stratified into an upper and lower layer separated by clean sand, while one test pit excavated in 1969 showed a stratigraphy of four layers. Law (1972, p. 85) has pointed out that on the basis of structural evidence the sterile sand layer does not necessarily mean a long occupation hiatus, while all the other test pits show only a single occupation. Similarly, the homogeneity of the assemblage and faunal remains indicate "a provenly single period assemblage" (Law 1972, p. 85).

The location of the site allows exploitation of a number of varied ecological zones: rocky shore environment, open water, coastal forest, fertile soils — either for fern root collection or agriculture. The faunal remains provide evidence that all these potential resource zones were exploited, while the assemblage demonstrates both the means of exploitation and the manufacture of necessary equipment at the site. As well as exploitation of the immediate environment there is evidence for outside contact — shell-fish species not found in the immediate vicinity are of importance to local resource distribution while the high percentage of Mayor Island obsidian has New Zealand-wide implications (Green 1964).

For the exploitation of the rocky-shore environment little equipment is needed except perhaps a wooden or bone implement for detaching some species, and flax bags. It is, therefore, not likely that this economic stratagem will be reflected in the archaeological assemblage, despite its importance for coastal sites.

The occurrence of one-piece fish-hooks and the high percentage of snapper (93%) in the midden demonstrate the importance of line-fishing, while broken unfinished hooks, tabs and cores show that hooks were manufactured at the site. A lure shank of moa-bone and a shell point show exploitation of pelagic species, e.g. kahawai, by trolling although no remains of such species were recovered. However, the effect of these manufacturing activities on the obsidian assemblage may have been minimal with drills of siliceous material and rhyolite abraders being used instead of obsidian, which is too brittle for effective bone-work. Law (1972, p. 97) notes one abrader of unusual wear consistent with shaping the wide curves of fish-hooks. Ethnographic accounts have stressed the importance of nets in Maori fishing and undoubtedly these would have been in use, although little archaeological evidence would be expected as netting was made by rolling vegetable fibres on the thighs (Best 1929, p. 10). The leather-jackets and butterfish in the middens must have been taken either by trapping (Witter 1969, p. 51) or with baited nets (Law 1972, p. 98). Of trap manufacture, Best (1929, p. 152) states "Some of the finest and neatest work on fishtrap making was that of the northern parts of the North Island — that is the folk who were able to procure as material the small long and pliant stems of the climbing fern called 'mangemange'," while slender stems 3/10 to ¼ inch (7.6-6.3 mm) in thickness were used for hoops in eel pots. Thus trap-making need involve only obsidian of the light usage category if used.

The butchering pattern exhibited by fish bone frequencies is no longer reconstructible. At Galatea Bay, Ponui Island, Shawcross (1967, p. 113) showed that there was a higher proportion of snapper head bones than body bones. This he suggests may be due to preservation by drying of the bodies which were taken elsewhere for consumption. Allo (1970, p. 91) suggests, instead, that the high frequencies of head bones both at Galatea Bay and Station Bay, Motutapu, may be due to differential survival. If eaten on the spot fish could have been prepared whole or merely gutted; the most one would expect from this, if obsidian was used, would be limited bifacial damage while the limited depth of penetration required for gutting means that any pieces of obsidian longer than 1.5 cm with a straight or convex edge less than 25° would suffice. However, if preparation involved removal of the head, as for preservation, then obsidians with the characteristic butchering pattern should occur.

Sea-coastal birds which were the majority of avifauna represented in the midden (75%) may have been taken during the breeding season or stranded on beaches at other times (Pike 1973), in either case minimal technology was required for exploitation. Forest birds may have been taken in three main ways (Ranapiri 1895) — by noose, snares at drinking troughs, or speared. The most efficient way was use of snares made of twisted fibre, but one bird spear tip was recovered and spear manufacture would have involved barking and smoothing of a shaft, i.e. burnishing/barking functional category.

Downes (1928, p. 9) records that bird bones and entrails were sometimes consumed but in Richdale's (194—, pp. 100-104) description of the preparation of mutton birds on Stewart Island, the feet were severed between tarsus and leg, the wings cut off above the humerus and the head and tail removed. The latter procedure would result in limited bifacial edge damage and possible striae and dulling. Whether this was done in the immediate vicinity of the site or elsewhere is relevant to the excavated assemblage, for the midden documents the pattern of disposal rather than the full range of activities carried out by the site occupants.

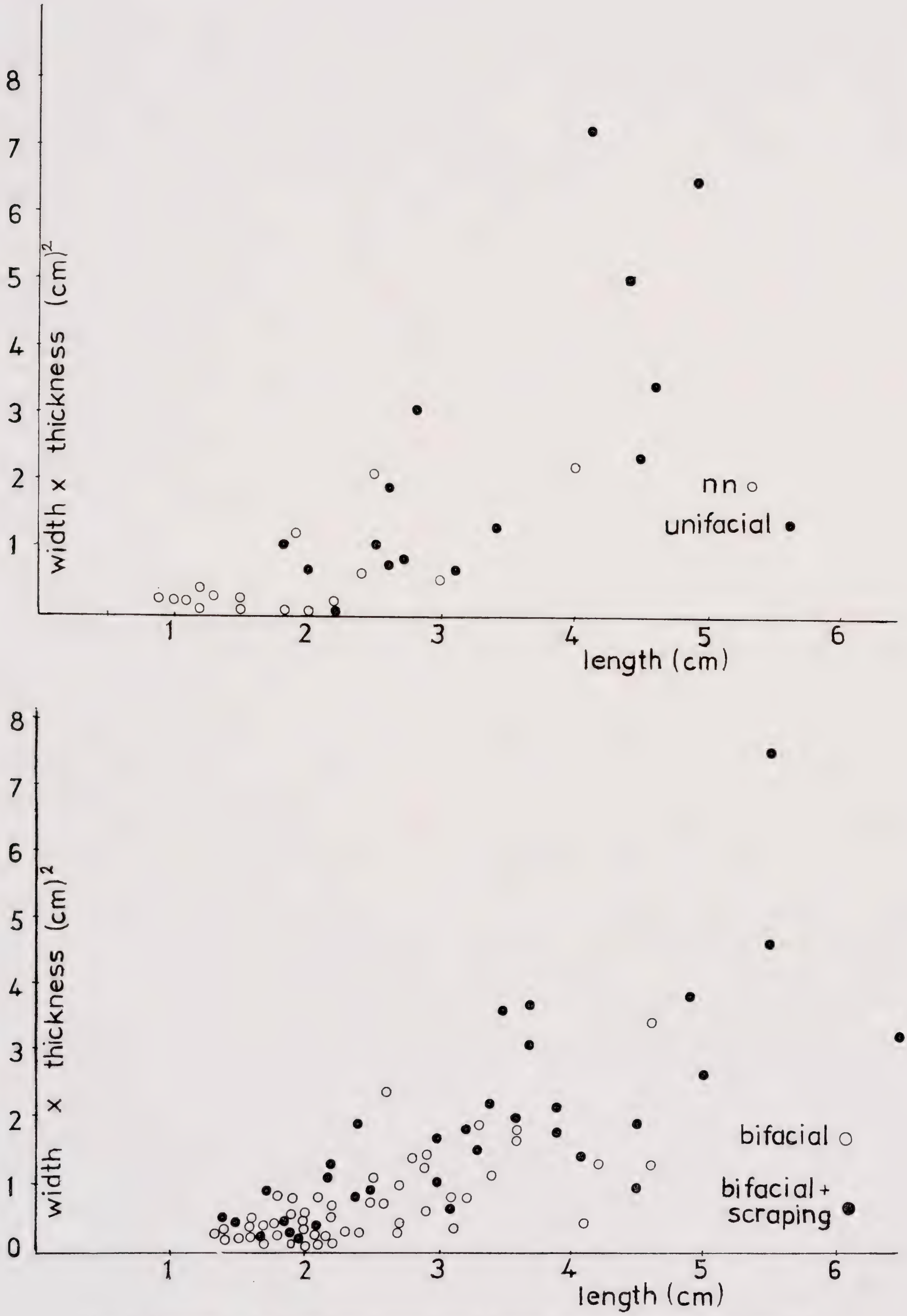

Fig. 5. Dimensions of obsidian from Great Barrier Archaic midden site, N30/5.

A skin burnisher (?), a needle, and awl, together with the remains of dog, seal, and moa, show that butchering and dressing was done at the site. Hence both skin scraping and heavy butchering functional factors are relevant to a use damage study at this site.

Stephen Edson of Auckland University (pers. comm.) has evidence for extensive agricultural systems associated with an Archaic culture on Great Mercury Island. Therefore, since pits on later sites in Harataonga Bay attest to the fertility of the area, some heavy woodworking could be expected in the manufacure of digging equipment for agriculture or fern root gathering. A final fact to consider is that the degree of social elaboration evident by the occurrence of a tattooing chisel, skin burnisher, etc, indicates an amount of leisure time which may have been invested in carving. This too could be reflected in the obsidian assemblage.

A comparison of graphs showing the size distribution of N30/5 obsidian (Fig. 5) and the Tokoroa material (Fig. 2) demonstrates the subjectively defined "heaviness" of the Tokoroa obsidians. On average the obsidians from all the coastal sites are smaller and the edge wear is less severe than that from Tokoroa (Fig. 6).

The size graph for N30/5 (Fig. 5) shows that pieces designated as "unused" are clustered in the small size range. Eighty-seven per cent of the obsidian was identified as used, exactly the same percentage as for Tokoroa, and, therefore, it would seem that the 13% of "not necessarily used" in these assemblages results from the difficulty in identifying use of small acute angled tools (Fig. 6).

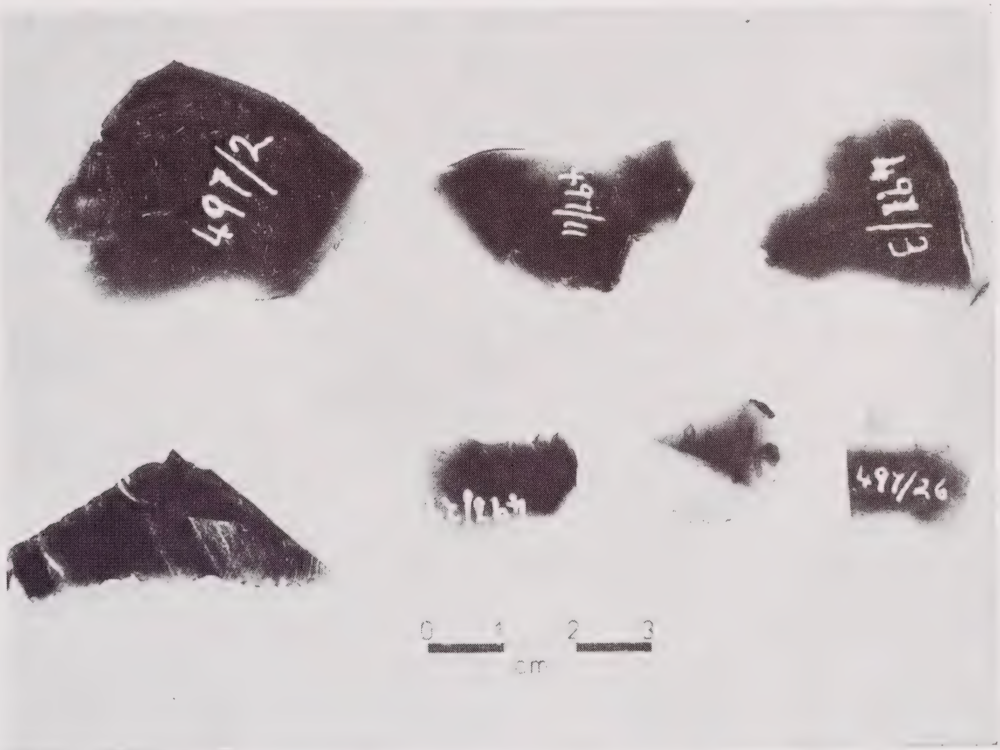

Fig. 6. Obsidian showing smaller size range and less severe edge wear, typical of Great Barrier coastal sites N30/5, N30/4 and N30/3.

As scraping is a feature of maintenance activities the reduced ratio of unifacially damaged/bifacially damaged edges and their reduced co-occurrence to 29% (c.f. 42% for Tokoroa) indicates an increase in light usage and food preparation activities (Table 2, Fig. 7). This is expected in a comparison between both the potential food resources and midden remains from Tokoroa and Harataonga Bay. However, microscopic examination did not reveal any positive criteria of butchering and it is suggested that food preparation did not involve procedures necessary for preservation, e.g. fish-head removal. This supports Allo's rather than Shawcross's argument concerning the frequency of fish-head bones in middens (Allo 1970, p. 91; F. W. Shawcross 1967, p. 113). Archaic economy, therefore, may have been coastal based all year round in contrast to later accounts. For example, K. Shawcross (1967) records that there was a seasonal migration from interior to coast by one-third of the Bay of Islands population.

Table 2. Analysis of obsidian, N30/5.

	No.	%
No. of pieces studied	116	
No. showing use	101	87
No. of working edges	116	
No. of edges showing bifacial damage	90	78
Co-occurrence of bifacial damage + scraping criteria		29

The high percentage of used obsidian, which is probably a conservative figure, implies that the manufacture of obsidian tools, and probably the use, did not occur in the excavated area. Jones (1972) has suggested that obsidian was dumped in places where it was not likely to be trodden on. If this is correct then the excavated area was for refuse disposal rather than a living area, an interpretation supported by the non-functional condition of the formal artifact types recovered. The only evidence for use of the excavated area other than for dumping was in the upper layer of square B2 where an oven and adjacent lens of clay were found: only one piece of obsidian came from this level. The laying down of 20 cm of clean sand under this then, may mark a temporary change in the use of one portion of the site rather than an occupation hiatus.

In contrast to the other sites studied the flake assemblage from N30/5 was not predominantly of obsidian, but also comprised 228 basalt flakes and 223 siliceous flakes. Basalt is a homogeneous, partially vitreous, tougher material, but working edges are not as sharp as those of obsidian and, while siliceous materials are homogeneous, tough and sharp, they lack the keenness of edge found in obsidian (Crabtree & Davis 1968, p. 427 for a table of properties). It is hard to assess the effect that the availability of these other materials may have on the obsidian component of an assemblage, but their properties make the materials more suited to heavy woodworking and bone working in particular, than obsidian which is brittle.

Great Barrier Beach Midden (N30/4)

Located on a natural terrace behind the beach, this site is an area of diffuse midden, several ovens and a line of fifteen post-holes running along the outer edge of the terrace. The site, therefore, was used primarily for food preparation, a fact consistent with the paucity of artifactual material — thirteen pieces of obsidian, two siliceous flakes, a piece of worked bone and two dentalium shell sections. The

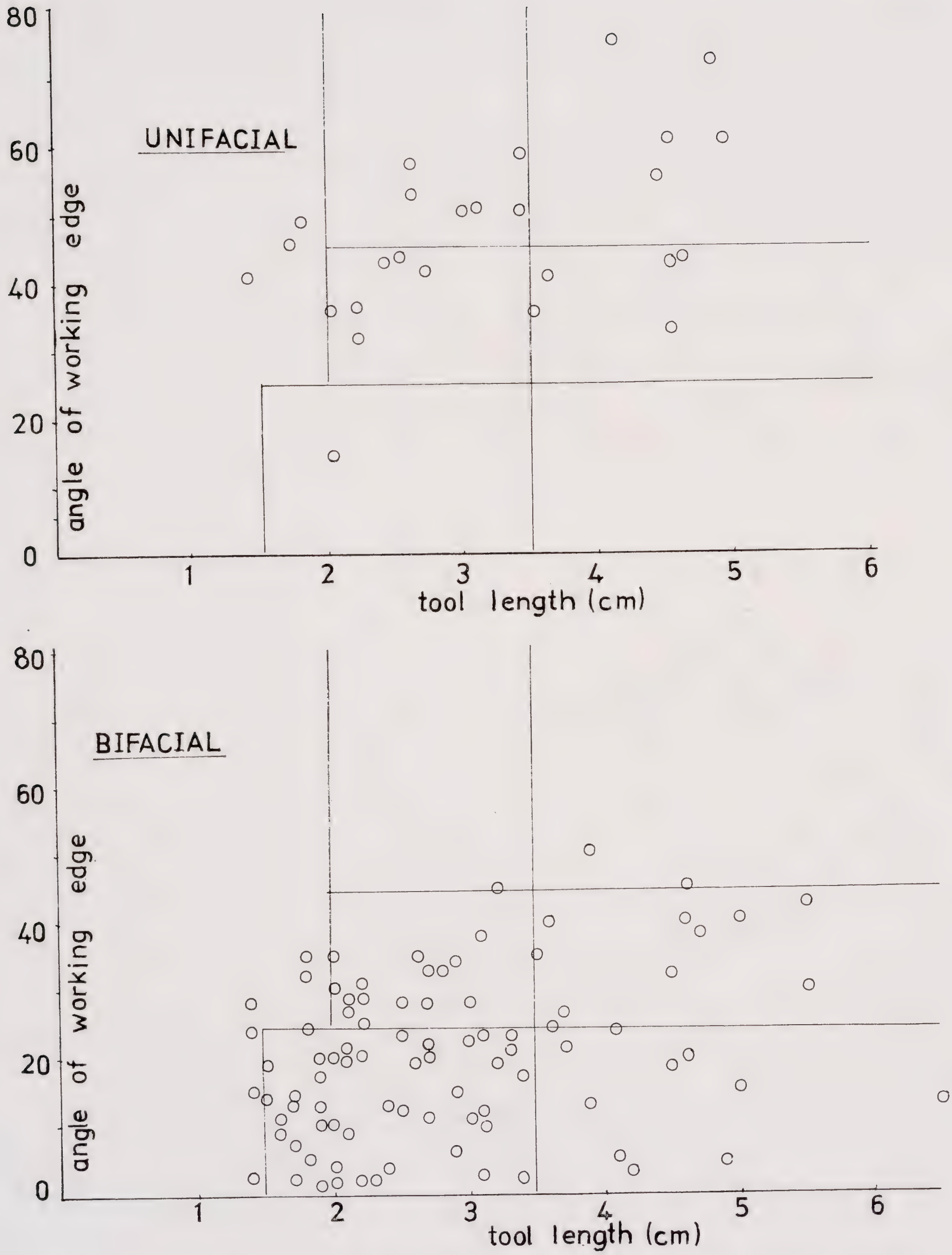

Fig. 7. Functional distribution of used obsidian from Great Barrier Archaic midden, N30/5.

stratigraphy was basically a layer of diffuse midden of variable depth overlaying white beach sand into which ovens had been dug. An earlier restricted cultural deposit is not significant to the assemblage as all the material recovered was from the final occupation.

Law (1972, p. 110) has argued that this site is later in the sequence than N30/5 on the basis of its specialised nature, and the absence of Archaic artifacts and extinct birds. Dates are now available for the Harataonga sites (Law 1974). N30/5 is indirectly dated to the 13th century A.D. by association with Loisel's pumice, while the other sites have been dated by 3 radiocarbon age determinations. Two results from N30/4 yield a pooled mean of 231 ± 40 B.P. which gives a best age of A.D. 1610-1660 at one standard deviation. At N30/3 a single date from a burnt post at the base of the pit fill is 441 ± 55 B.P. which gives a best date of 1390-1440 at one standard deviation.

All but one of the nine pieces of obsidian studied showed signs of use (Table 3), and it is noticeable in Figure 8 that this unused piece differs significantly in its length x breadth measurement. This specimen is also water-worn and it may have been

Table 3. Analysis of obsidian, N30/4.

	No.	%
No. of pieces studied	9	
No. showing use	8	89
No. of working edges	8	
No. of edges showing bifacial damage	7	87.5
Co-occurrence of bifacial damage + scraping		28

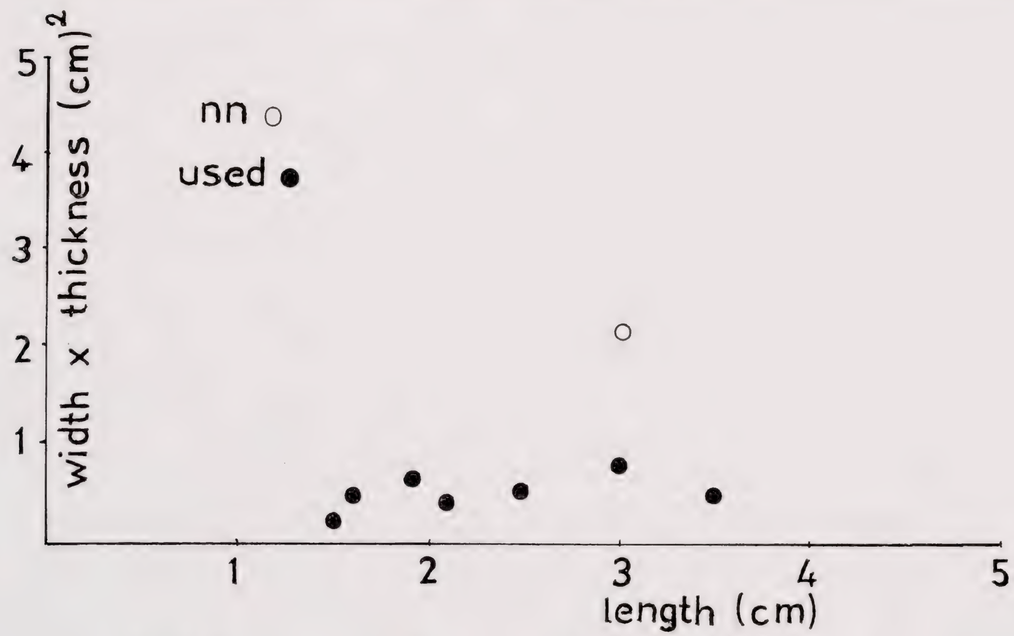

Fig. 8. Dimensions of obsidian from Great Barrier beach midden, N30/4.

eroded out of an earlier site and kept by the inhabitants of N30/4 for future use. All of the bifacially damaged tools fall into the light usage category, suggesting light manufacturing activities and gutting. This is consistent with the one unifacially damaged tool being suitable for light woodworking while the two edges from which dimensions of the worked material are reconstructible show the working of shafts some 6 mm in diameter. The functionally specialised nature of the obsidian assemblage mirrors the functional specialisation of the site, while the range of angle and length values is appropriate to the range of activities indicated by other evidence, i.e. food preparation and some manufacturing. The tools are definitely not suited for heavy wood or bone work and also lack the severity of edge damage which would be associated with this. The presence of a piece of worked seal bone indicates a limited amount of bone working was carved out at the site and the two siliceous flakes may have been used for this. In comparing the Archaic site N30/5 with N30/4 it is noticeable that the marked decrease in the occurrence of siliceous material parallels a marked decrease for evidence of bone working.

Law (1972, p. 106) reports that the obsidian from this site averaged less than one-third of the size of obsidian from N30/5 and a comparison of the dimension graphs for both sites (Figs. 5, 8) amply demonstrates this. This analysis demonstrates that the difference is of functional rather than cultural significance (Fig. 9).

The midden material from N30/4 shows a greater reliance on shell-fish and a substantial reduction in the variety and number of birds in comparison with N30/5. The difference, however, is a change of degree rather than kind and the sites show similar economic strategies and presumably, therefore, similar activities were involved

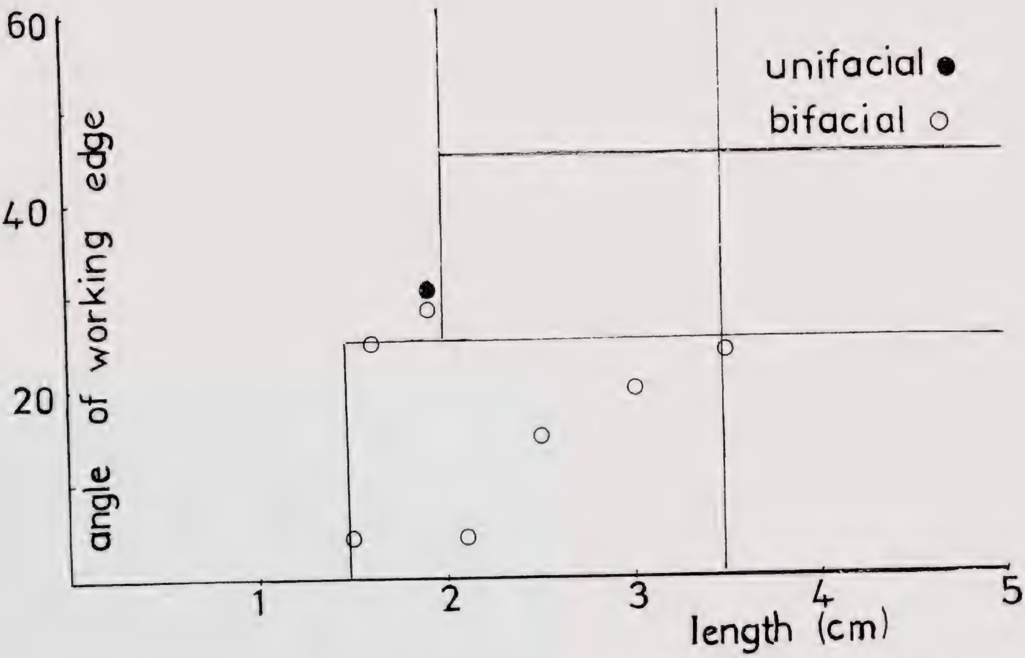

Fig. 9. Functional distribution of used obsidian from Great Barrier beach midden, N30/4.

in resource exploitation. Once again, as at the Tokoroa site, the question of archaeological sampling, as well as the distribution of past activity areas, is basic to a reconstruction of prehistoric behaviour.

Great Barrier Pa (N30/3)

This is a small pa site on a low headland above N30/4. There is a single defensive ditch and only one pit evident, though others have possibly been covered by sand. Excavation revealed a complex stratigraphy and, therefore, site history, involving 6 layers, but as all but one piece of obsidian derived from the top layer this is not really relevant to the excavated assemblage. Besides obsidian the assemblage included a worked piece of dog mandible, six worked pieces of albatross bone, a piece of basalt boulder, fossilised wood, kauri gum, red and orange ochre and eighteen flakes of siliceous material.

The high percentage of "unused" obsidian contrasts with the percentages obtained for the other sites and this, plus the recovery of one large obsidian core, suggests that here obsidian tools were being manufactured as well as used (Table 4). The unused obsidian was of small size (Fig. 10), a feature expected of industrial waste, and this plus its numerical significance explains the fact that average size by weight was smaller than for N30/5. The differing size distribution of obsidian from these sites is, therefore, primarily due to a difference in site use. The small ratio of unifacially/bifacially damaged edges and the 28% co-occurrence of bifacially damaged edges and scraping criteria indicates light woodworking and light usage activities (the reconstructed size range of worked materials shows all to have been 1 cm or less in diameter). Bone working evident at the site was probably carried out using siliceous material. As with the other sites the broad distribution of angles for unifacial and bifacial edge damage conforms to experimentally-derived predictions and unifacially damaged edges are, with few exceptions, greater than 25° (Fig. 11).

Table 4. Analysis of obsidian, N30/3.

	No.	%
No. of pieces studied	169	
No. showing use	74	44
No. of working edges	87	
No. of edges with bifacial damage	67	77
Co-occurrence of bifacial damage + scraping		28

Microscopic examination of the assemblage revealed that at least two specimens (Catalogue Nos. AU969/44, AU963/67) had longitudinal and transverse striations which, together with evidence of depth of penetration, indicated use for butchering. This type of activity and the use-wear severity was not consistent with hand-held use for tools of the size in question (1.5 cm maximum dimension). Although further examples of this use-wear type were not identified, the size distribution of light cutting specimens suggests that obsidian of this size and angle range may have been elements in a composite tool in the same way that sharks' teeth are known to have been hafted, for example, Hamilton (1908, p. 71) reports that sharks' heads were cut off with a sharp-toothed knife, made from sharks' teeth set in and tied tightly to a wooden handle. Evidence of a different type of hafting was found on a specimen

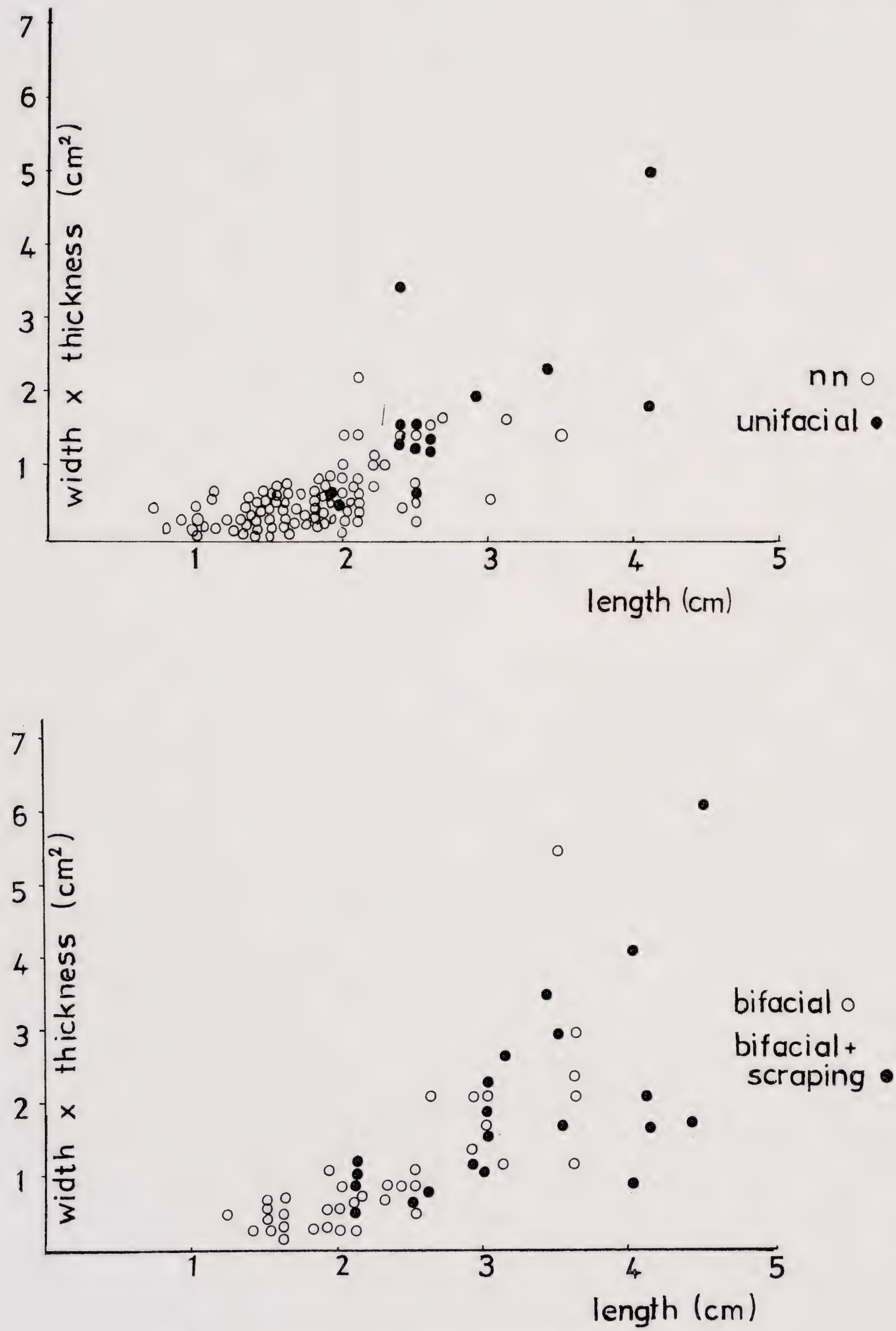

Fig. 10. Dimensions of obsidian from Great Barrier pa site, N30/3.

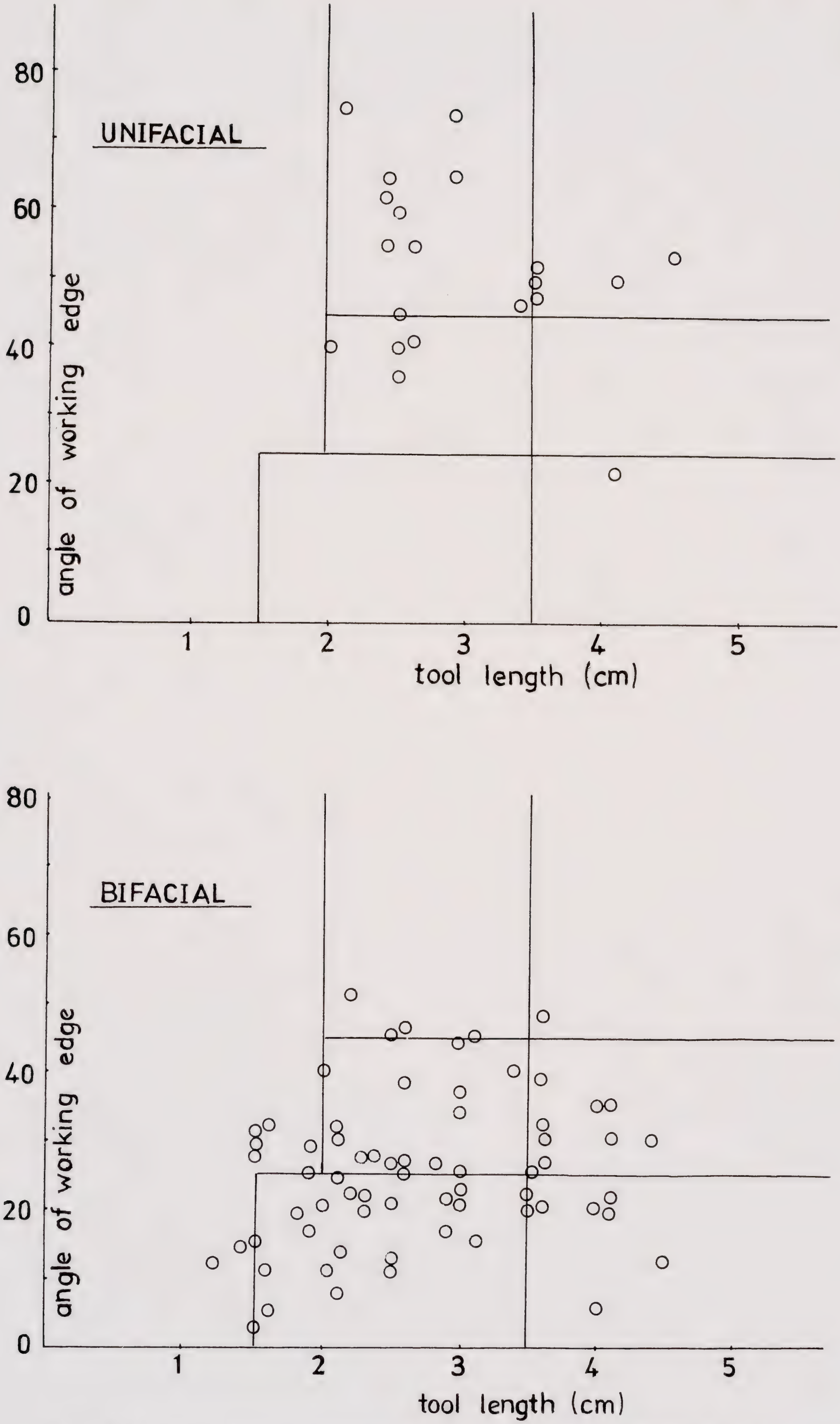

Fig. 11. Functional distribution of used obsidian from Great Barrier pa site, N30/3.

Fig. 12. Obsidian tool, specimen No. AU949/5. Maximum dimension 1.5 cm. Heavy edge damage is not compatible with hand held use, while lateral crushing (arrowed) shows contact with haft.

from the light woodwork functional category (Fig. 12). This specimen (AU949/5) is a micro-blade (maximum dimension 1.5 cm) with heavy unifacial damage at the distal end. The severity of edge damage is far greater than expected for a tool of this size and microscopic examination revealed minute lateral crushing of the edges where the obsidian made contact with the haft. Wilmsen (1968, p. 161) has described the lateral crushing of scrapers where the haft met the tool.

Some ethnographic accounts indicate extremely casual types of "hafting" such as holding the tool in grass or a dry leaf to increase grasping ability (Harry Allen pers. comm.). Identified examples of hafting may constitute only a small number of the specimens hafted in prehistoric times. Since hafting was a feature of this assemblage then this culturally significant feature could also affect functional categories.

The distribution of obsidian through the stratigraphy has interesting implications. The basal levels of the pit document use of the pit for storage, while the digging of two ovens and the later accumulation of diffuse midden shows use of the pit for cooking and possibly as a living area. Evidence of use of the pit for a variety of activities contrasts with the fact that only one piece of obsidian was recovered from those levels. The majority of obsidian was obtained from the top layer and it is suggested that it was deposited after use of the site for other activities had ceased. The high frequency of obsidian in or just under the top-soil seems a feature of many Auckland terrace sites and is evidence for the pragmatic separation of living areas and areas for obsidian tool manufacture and disposal.

Inter-site Discussion and Comparisons

The analysis of flaked material from the four sites demonstrates that White's thesis (see p. 80) is only partially correct. Flaked tool assemblages are sensitive to differing patterns of activity and can, therefore, provide evidence of economic type. Consideration of each site in isolation has yielded information on site activities and has implications for any future technological studies that may be performed on the materials. For instance, a technological study which did not take into account the high percentage of "unused" obsidian at N30/4, or the functionally specialised nature of the assemblage from N30/4, would demonstrate a significant difference in size between obsidian from these sites and the Archaic sites N75/1 and N30/5. Assuming that the differences were culturally determined, one would conclude that Archaic sites are distinguished by the relatively high proportion of large obsidian tools. A functional analysis shows that this conclusion is not valid (on the basis of the four sites investigated) but occur because of the uncritically descriptive nature of the approach.

Six functional categories were used for inter-site comparison based on the experimental results (Morwood 1974). These were as follows.

(1) Light usage I	(<25°) U	(1.5 - 3.5 cm)
(2) Light usage II	(<25°) U	(>3.5 cm)
(3) Light woodworking	(25 - 45°) U	(2 - 3.5 cm)
(4) Wood-working	(25 - 45°) U	(>3.5 cm)
(5) Burnishing/barking I	(>45°) U	(2 - 3.5 cm)
(6) Burnishing/barking II	(>45°) U	(>3.5 cm)

Although there is definite evidence of hafting in at least one assemblage (N30/3), the 3.5 cm length, which experimentally was shown to be the minimum for an unhafted power grip, was maintained. This was not only because most tools have edge-wear consistent with hand-held use but also because of the implication for prehistoric resource conservation and technology. For example, hafting may be shown by the presence of small tools with heavy edge damage.

Table 5 shows numerical and percentage differences between functional categories of the various sites. Chi-squared tests of significance showed that some differences

Table 5. Summary of the site analyses.

		Functional categories 1	2	3	4	5	6
Tokoroa:	Number	81	28	102	86	63	120
	Percentage	(16.9)	(5.8)	(21.2)	(17.9)	(13.2)	(25.0)
N30/5	Number	49	11	26	14	9	7
	Percentage	(42.2)	(9.5)	(22.4)	(12.2)	(7.8)	(6.0)
N30/4	Number	6	—	2	—	—	—
	Percentage	(75)	—	(25)	—	—	—
N30/3	Number	23	12	19	14	11	8
	Percentage	(26.4)	(13.8)	(21.8)	(16.1)	(12.7)	(9.2)

apparent between the assemblages were significant or highly significant. Of particular interest were the highly significant differences between the Archaic sites of Tokoroa and N30/5 in Classes 1 and 6. The obsidian components of these flake tool assemblages then, do reflect the use by similar cultural groups of different environmental resource zones. The significant difference in Class 1 between the coastal sites of N30/5 and N30/3 documents the more specialised nature of activities at N30/3. The paucity of material from N30/4 and its restricted functional distribution is itself of importance but meant this could not be quantitatively tested. However, basic to the analysis is that obsidian use was selective. By negating the element of chance and using experimentally defined functional ranges in the analysis, differences are of assumed functional significance. A complication arises, however, in that chance is inherent in archaeological sampling techniques, and a major criticism of this analysis is that it is not based on total excavation of the four sites. The thesis that past behaviour can be reconstructed by partial excavation is dubious and seems incompatible with the task dispersal inherent in the concept of "activity" areas. To overcome this the excavated assemblages have been treated as total assemblages.

Difficulty was encountered in attempting to quantify intersite differences both for definition of cultural and environmental determinates of flake tool morphology and to derive a functional weighting factor for a technological study: of importance to a reconstruction of site activities is the distribution of parameters used in the study and if the distribution is summarised for intersite comparisons the procedure is self-defeating. Robinson similarity indexes were calculated for each pair of sites and the results arranged in an ideal Robinson matrix in which coefficient values steadily increase toward the diagonal along any row or column (Frost 1970, p. 194 for a discussion of similarity indexes and their use). Although the analysis showed that the obsidian assemblages from Tokoroa and sites N30/5 and N30/3 on Great Barrier were similar in their functional distributions, a functional interpretation based on obsidian tools only is misleading as basalt and siliceous flake predominance at N30/5 shows an intensity and range of manufacturing activities not present at the other sites. The more restricted range of artifacts and their specialised nature at the other sites then, may relate to their relatively impoverished environments; certainly cultural considerations seem peripheral. At Tokoroa this is related to the diffuse nature of the forest resources, while the separation and dispersal of activity areas in the later coastal sites (N30/4, N30/3) seems based on pragmatic rather than cultural factors, that is, the resulting patchiness of a man-modified environment. Use-wear on some obsidian from N30/3 is consistent with fish-head removal as would be required for preservation, and later groups may not have been coastally based all year round. Once again, however, resources depletion rather than cultural factors can explain the difference.

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